Subseasonal and Seasonal Precipitation: from Predictability to Prediction

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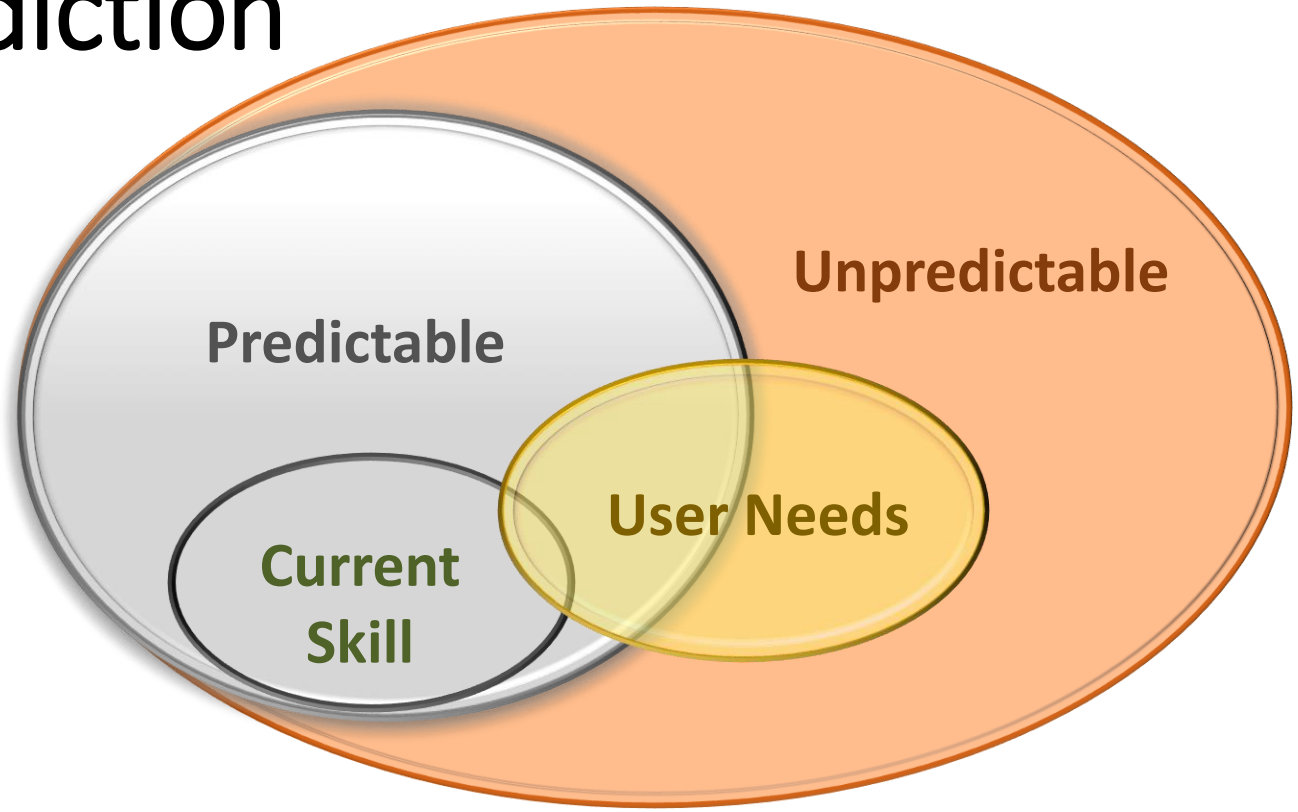
Thanks to: Emily Becker, NMME Team, SubX Team



How good are our predictions now?

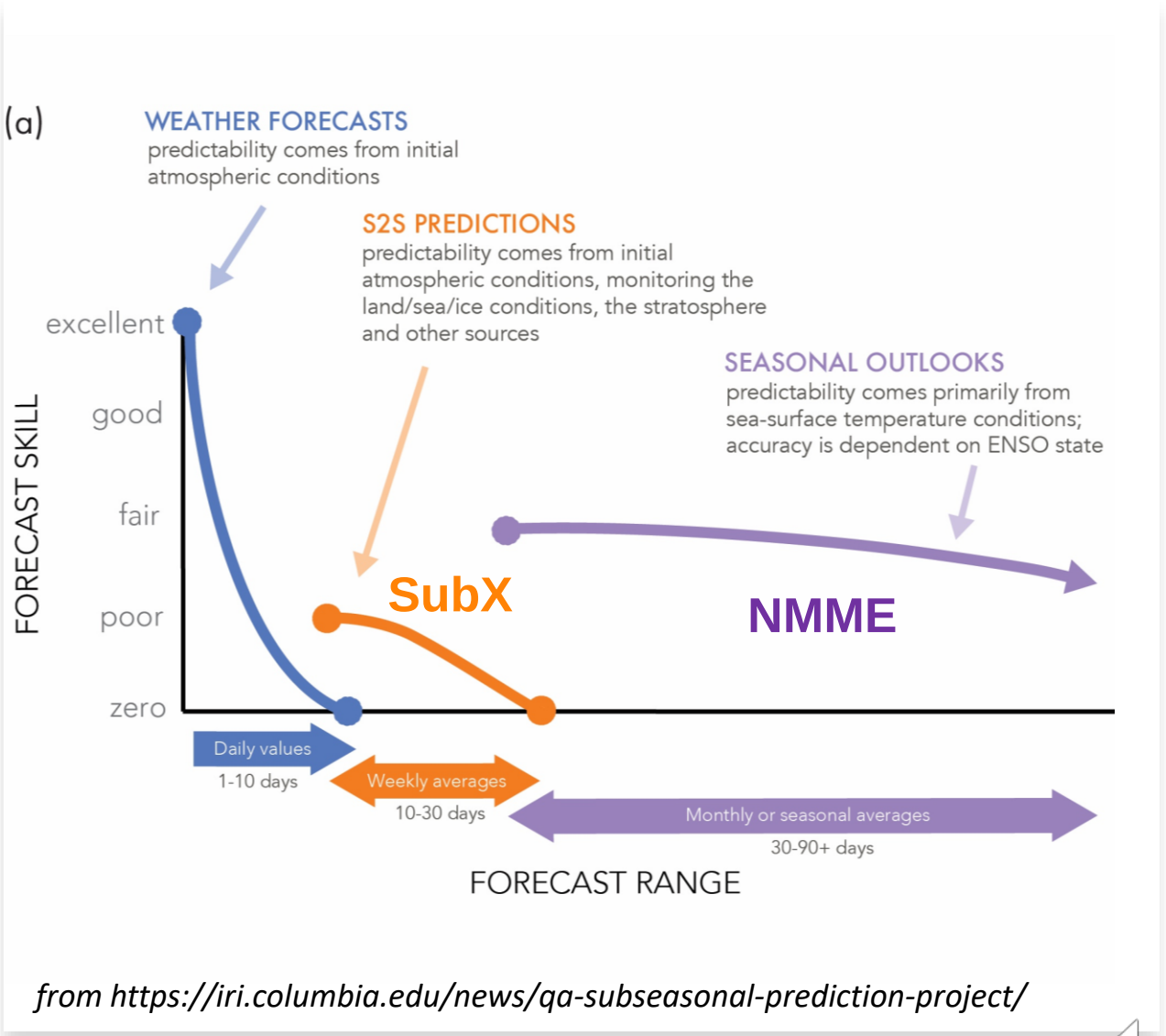
What is the limit of predictability?

How can we make better predictions?

Atmospheric, Oceanic, and Earth Sciences

COLA

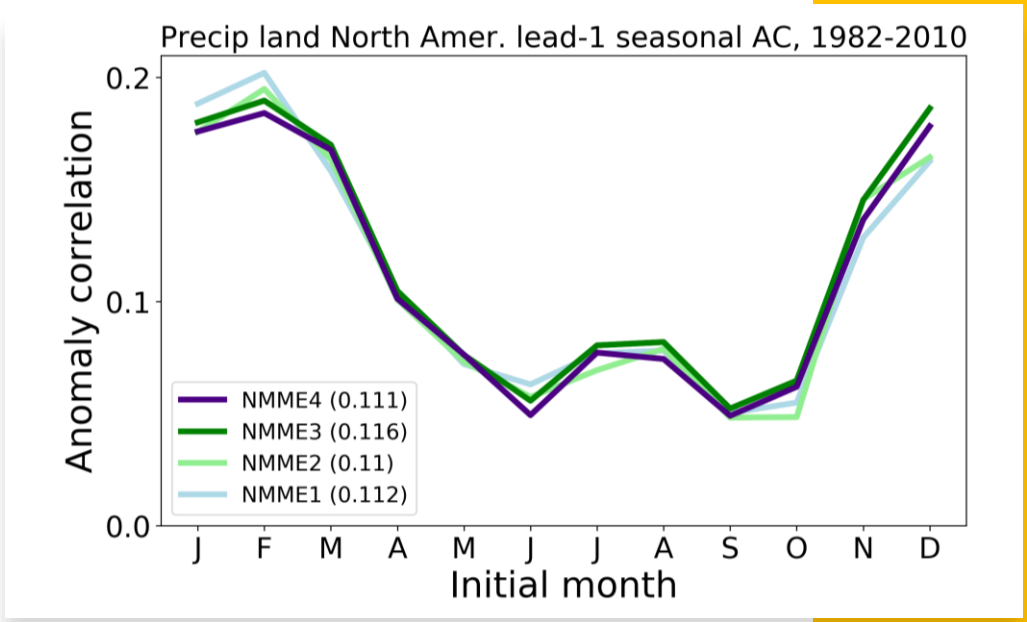
How good are our predictions now?

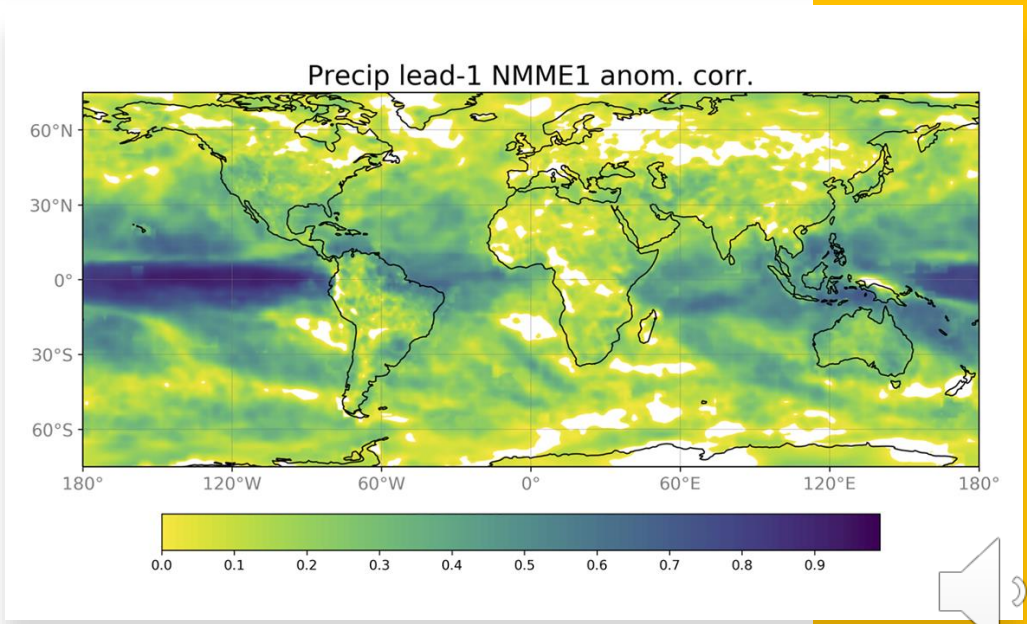


from https://iri.columbia.edu/news/qa-subseasonal-prediction-project/

North American Multi-model Ensemble (NMME)

- Varies in Space and Time
- Low over North America
- No significant improvement

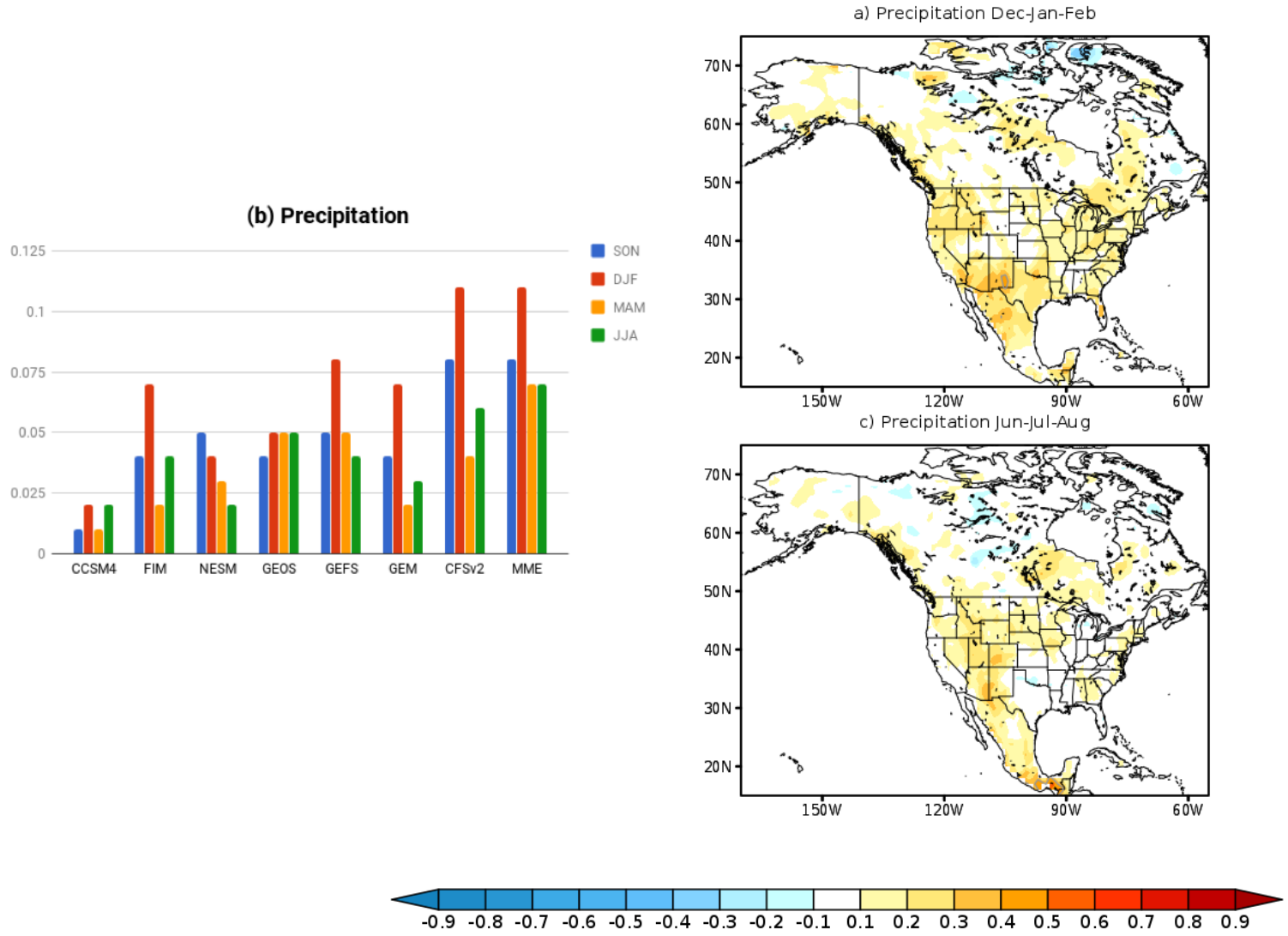




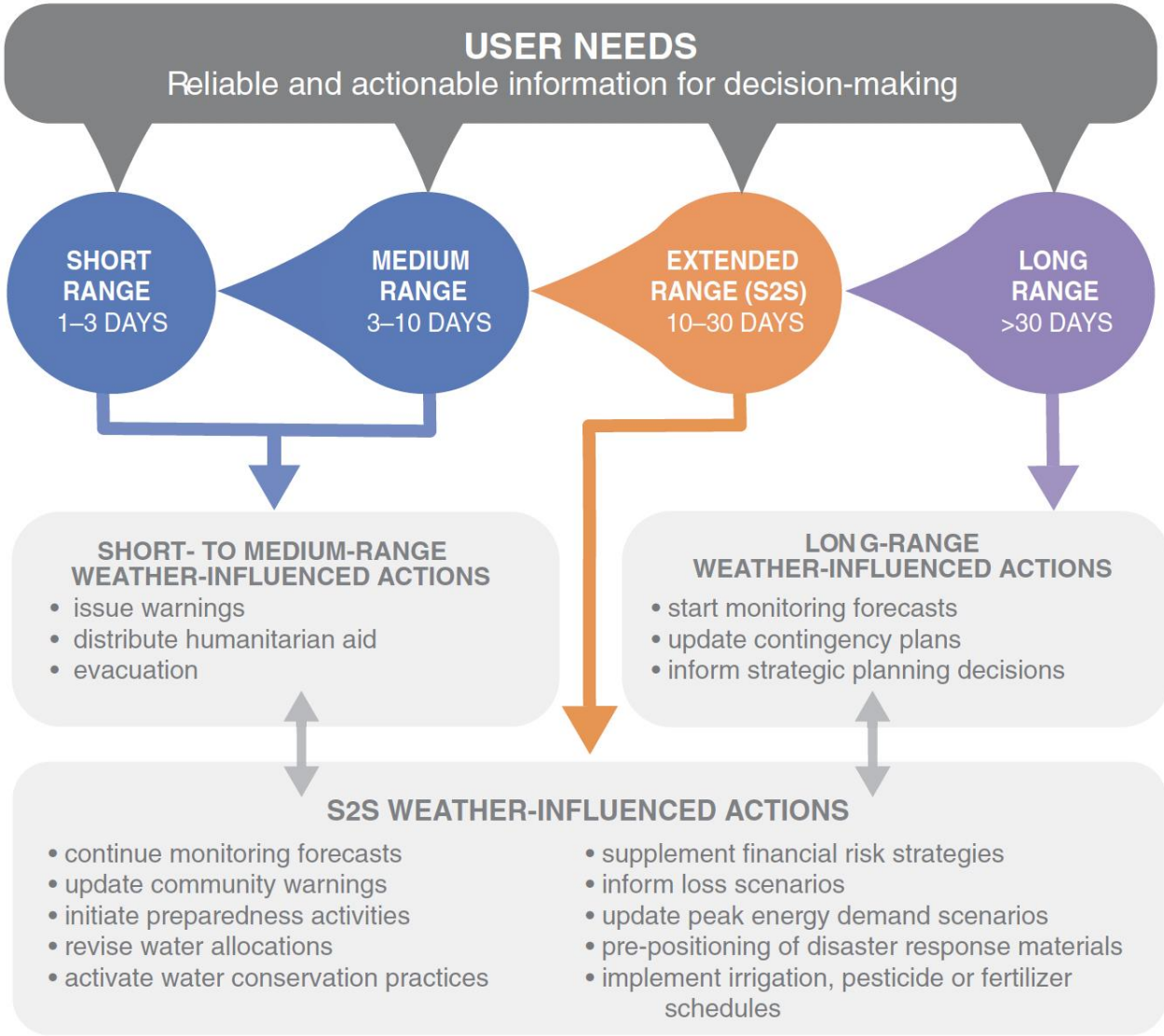
from Becker, Kirtman, Pegion, 2020, GRL

The Subseasonal Experiment (SubX)

- Varies in Space and Time
- Low over North America



from Pegion et al. 2019, BAMS

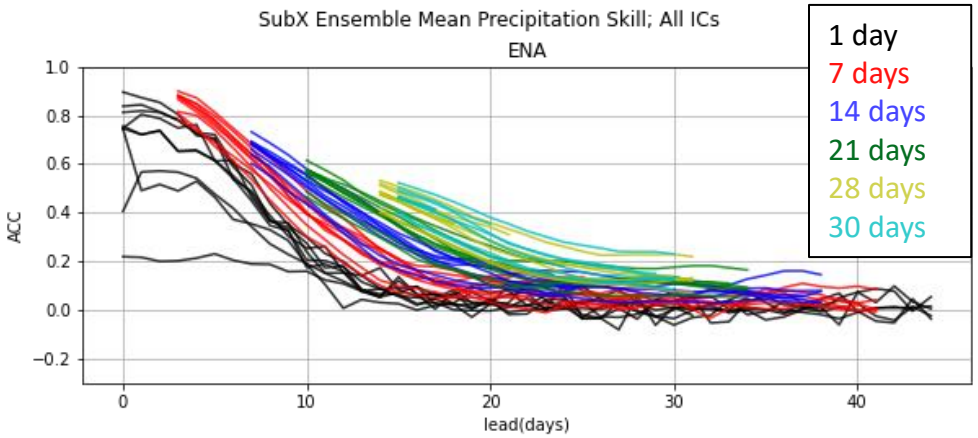


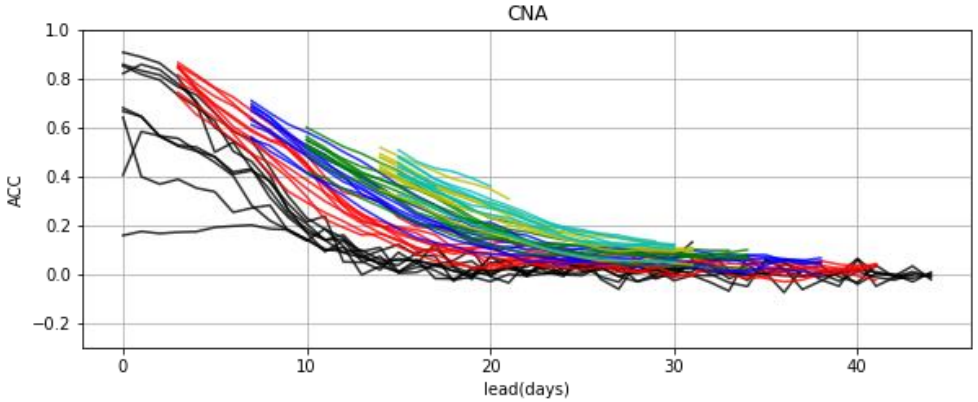
This timescale is used for planning

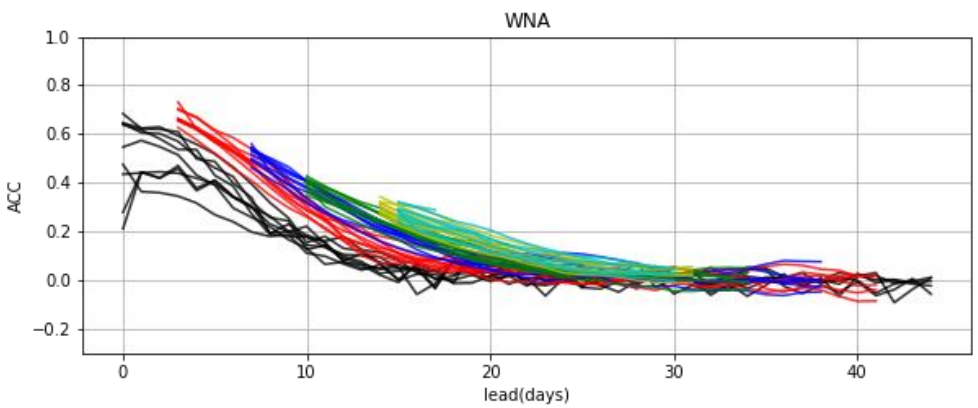
A flexible approach to assessing skill in space and time

from https://iri.columbia.edu/news/qa-subseasonal-prediction-project/

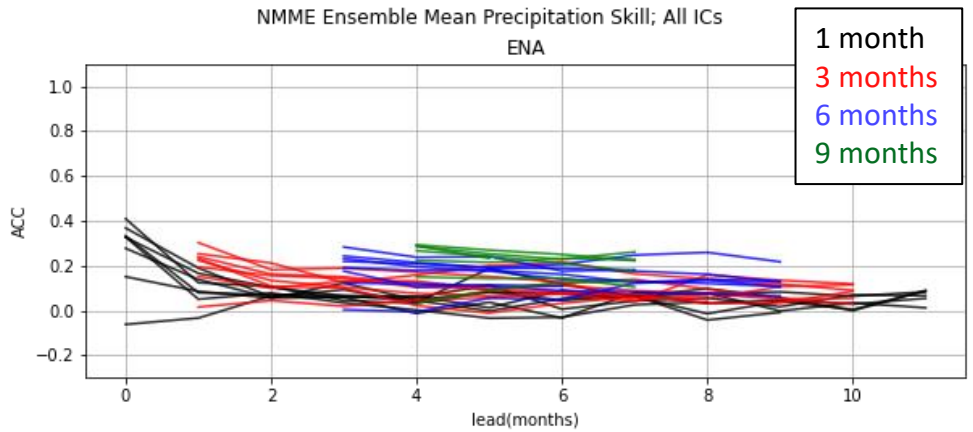
SubX

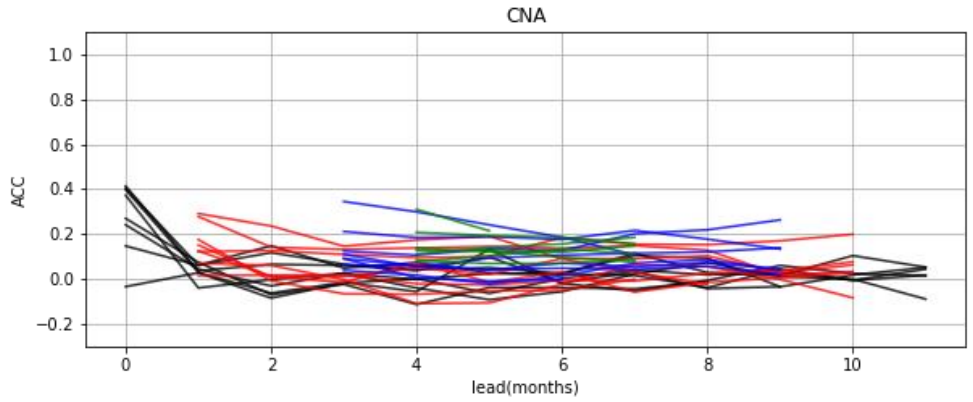


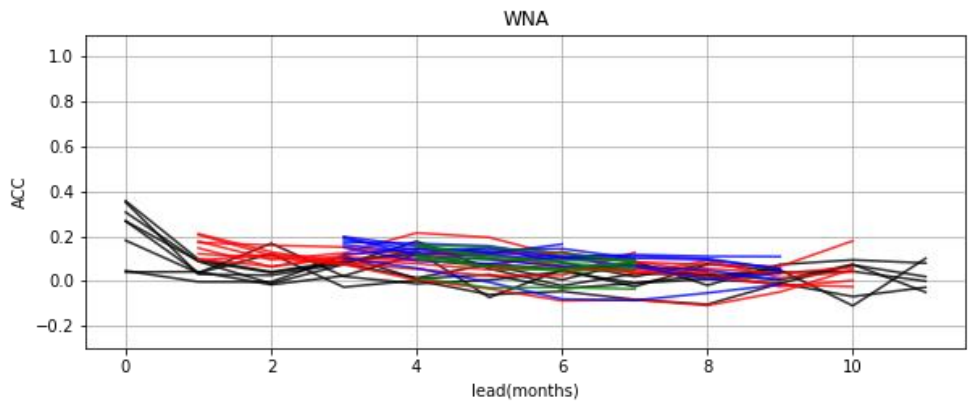


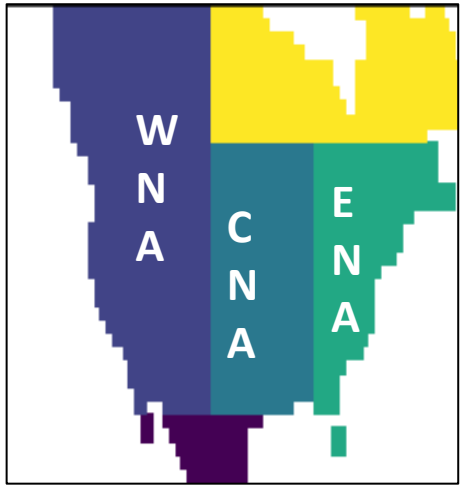


NMME







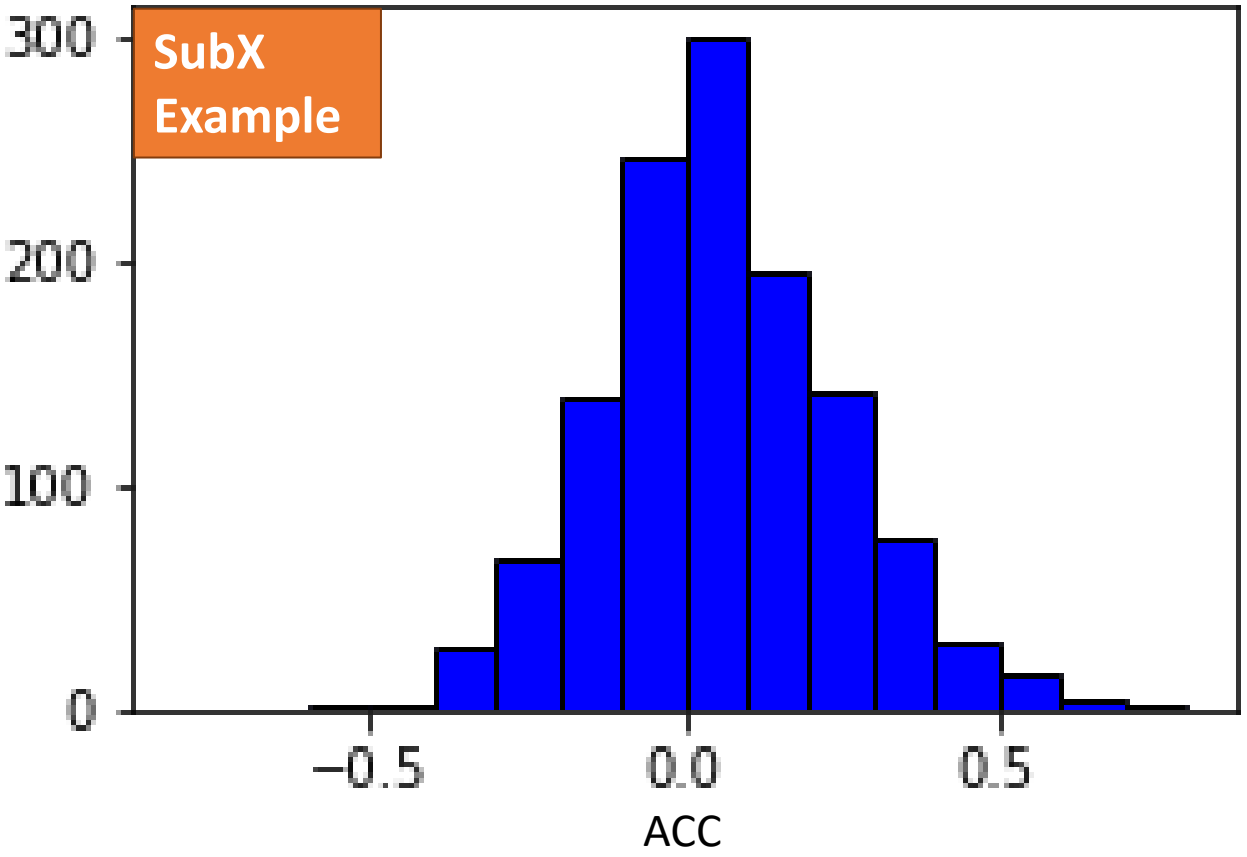


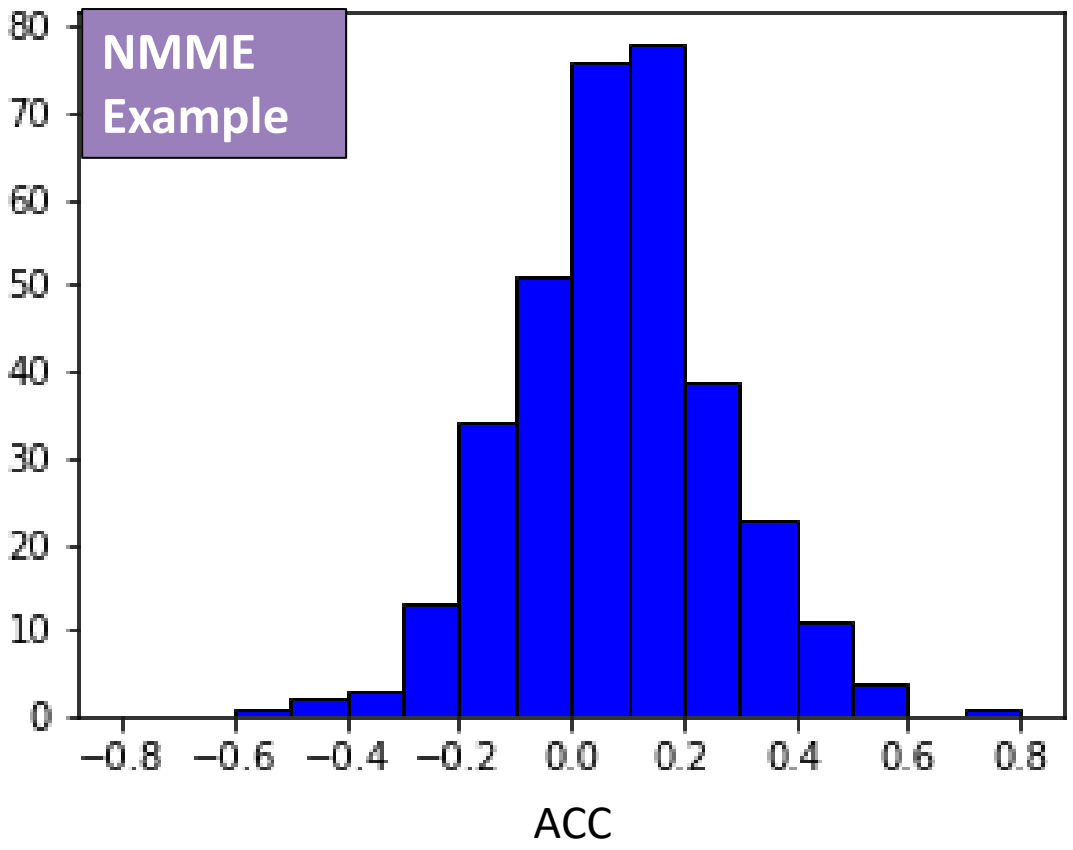
Better skill when averaged in space and time

On average skill is still relatively low

Explore other optimal approaches

Forecasts of Opportunity



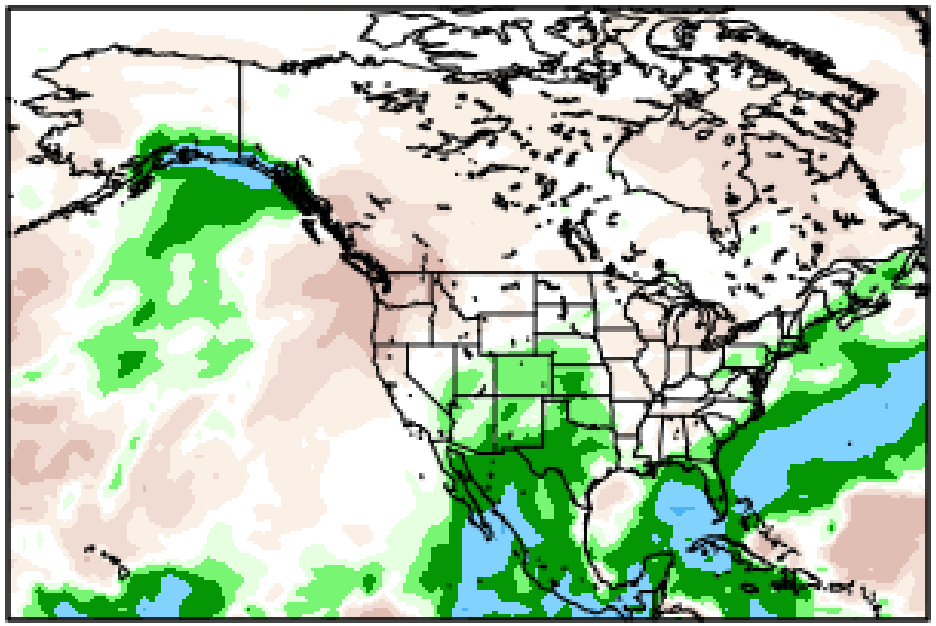


More positive than negative skill

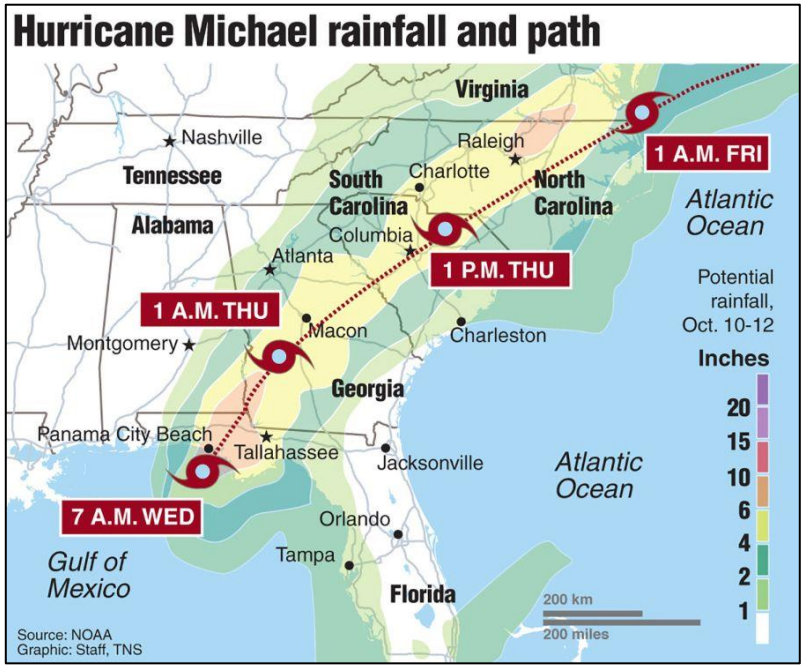
Higher skill at times

SubX Week 3-4 Total Precipitation Anomalies (mm): Valid 2 weeks ending OCT 19

MME (63 Ensemble Members)



from Pegion et al. 2019, BAMS



There is anecdotal evidence of useful forecasts that would not be skillful using traditional skill measures.

Can we find ways to identify, use, and quantify them?

What is the limit of predictability?

- Function of signal to noise:

$$P = F\left(\frac{\sigma_S^2}{\sigma_N^2}\right)$$

- Perfect model predictability

  Assume: Model is perfect, only source of error is initial condition uncertainty

  Signal = *estimated* by the ensemble mean

  Noise = *estimated* by the ensemble spread

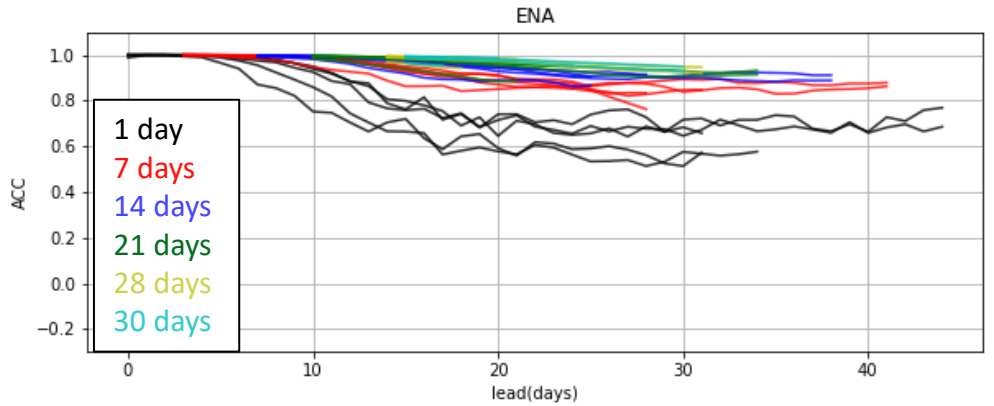
We do not know the upper limit of skill

Unrealistic estimates

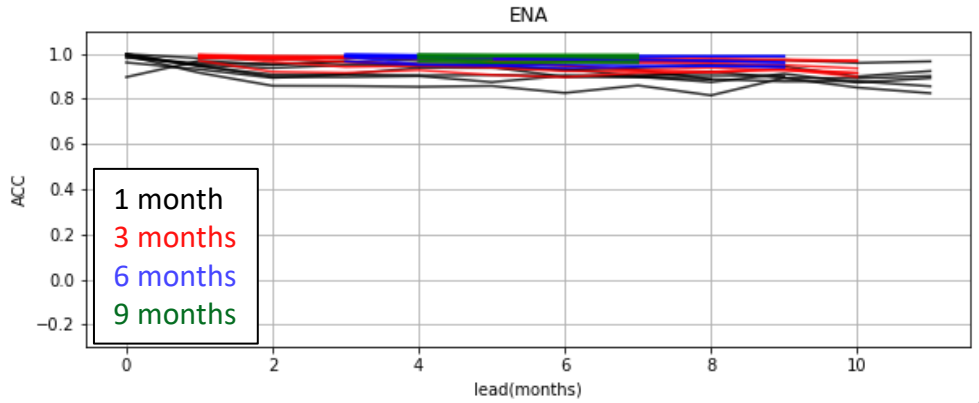
Noise is large at these timescales

Understand predictability by understanding signal

SubX



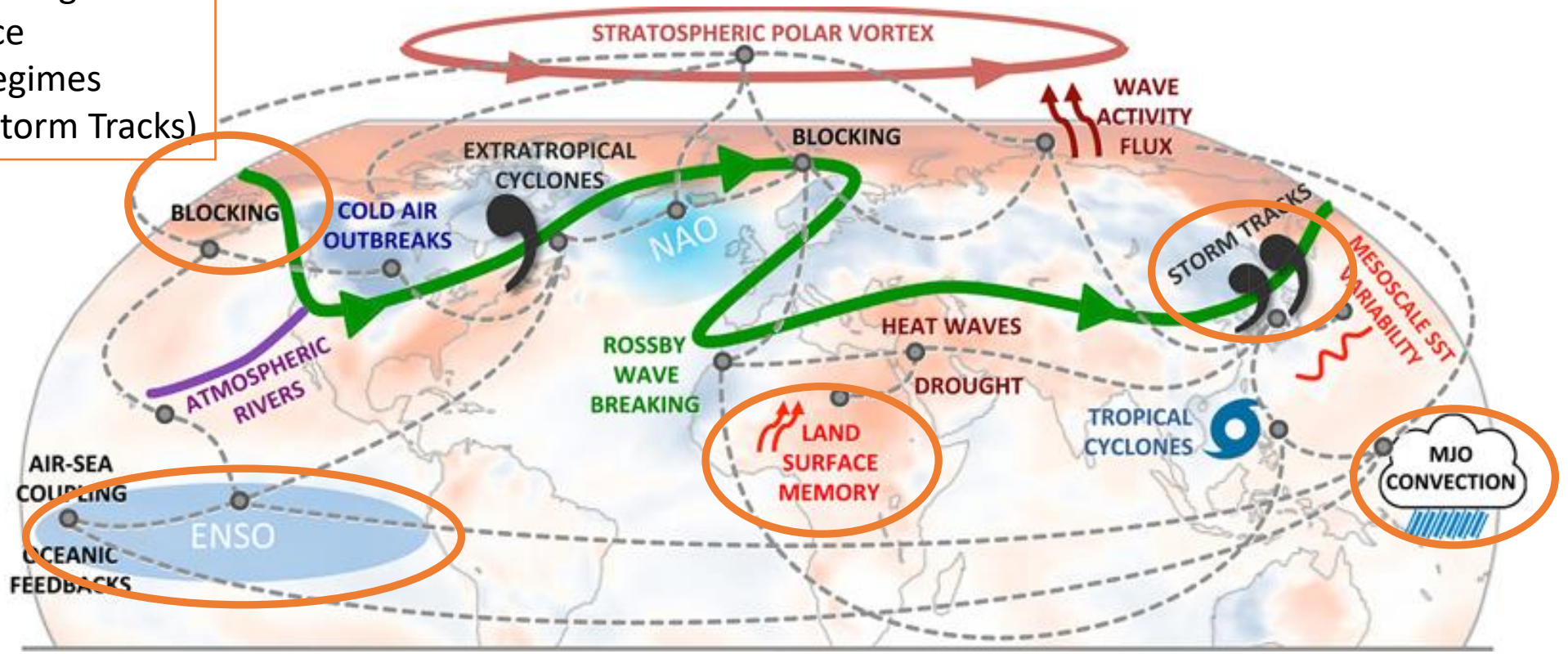
NMME



Understand Sources & Impacts

Subseasonal

- MJO
- ENSO
- Tropical Heating
- Land Surface
- Weather Regimes (Blocking/Storm Tracks)



from Lang, Pegion, Barnes, JGR Atmospheres 2020

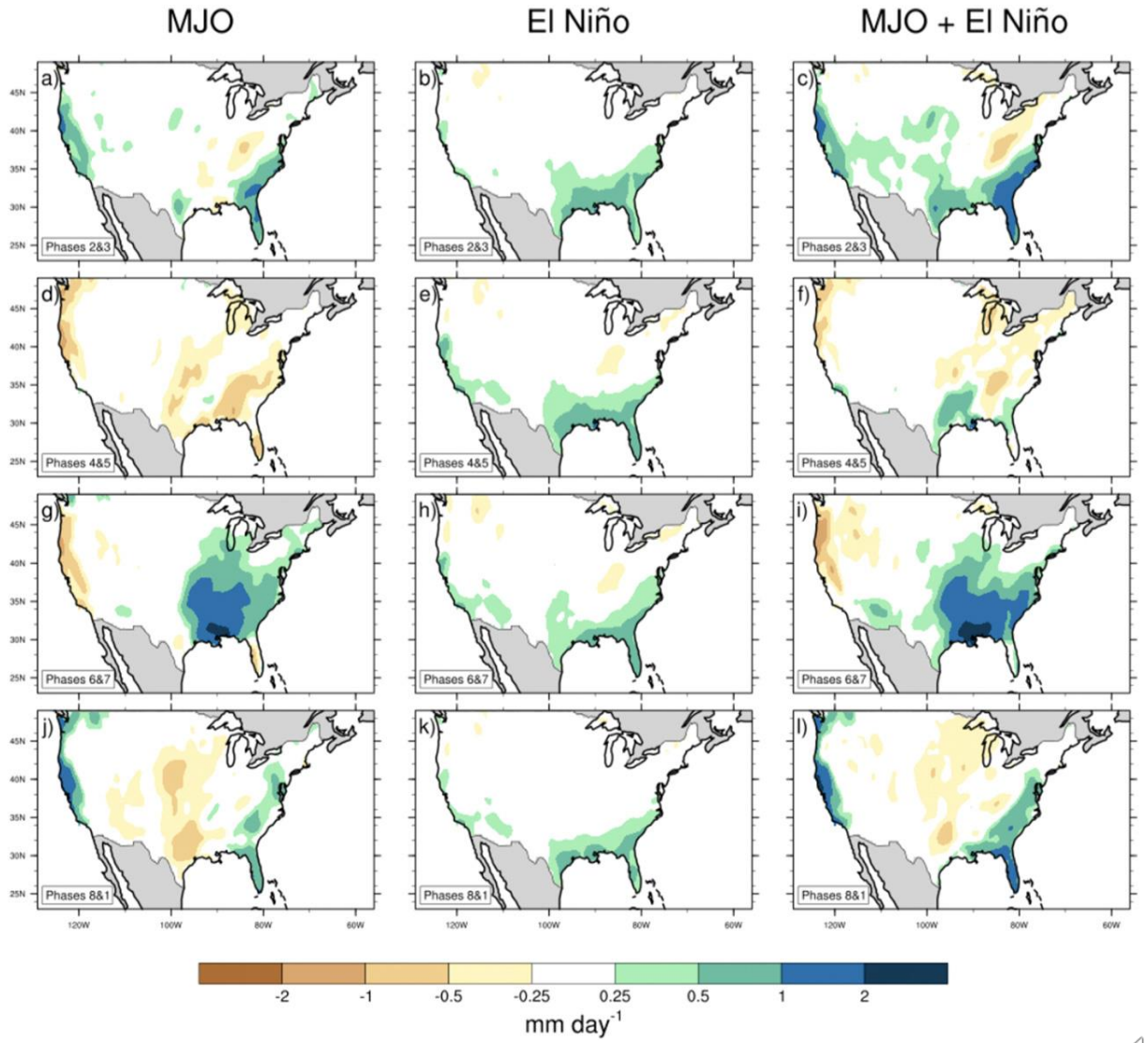
MJO and ENSO

MJO and ENSO interact to impact CONUS precipitation

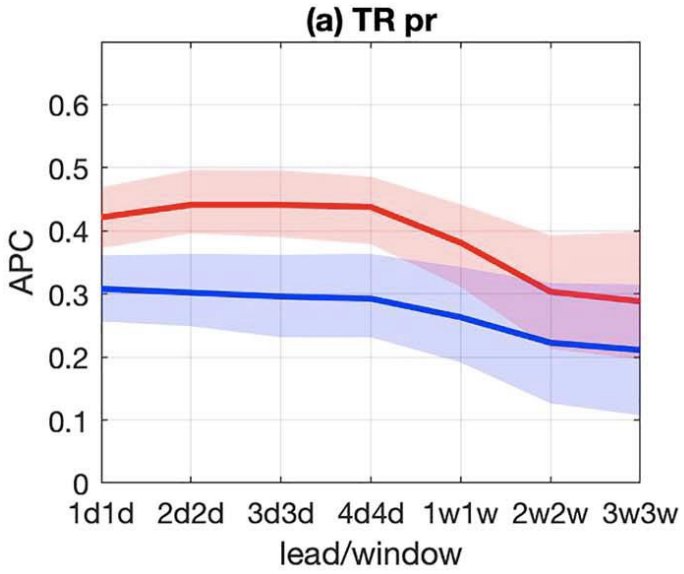
Still have fundamental MJO errors in our models (propagation, initiation)

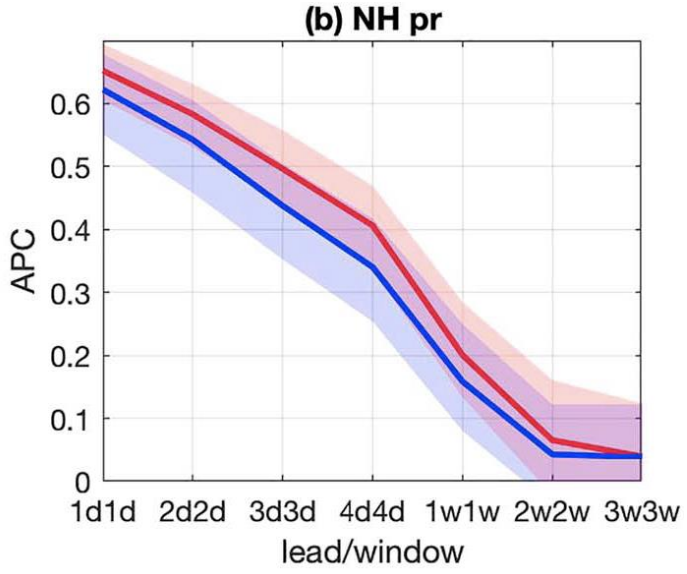
How well do our models represent these interactions and impacts on precipitation?

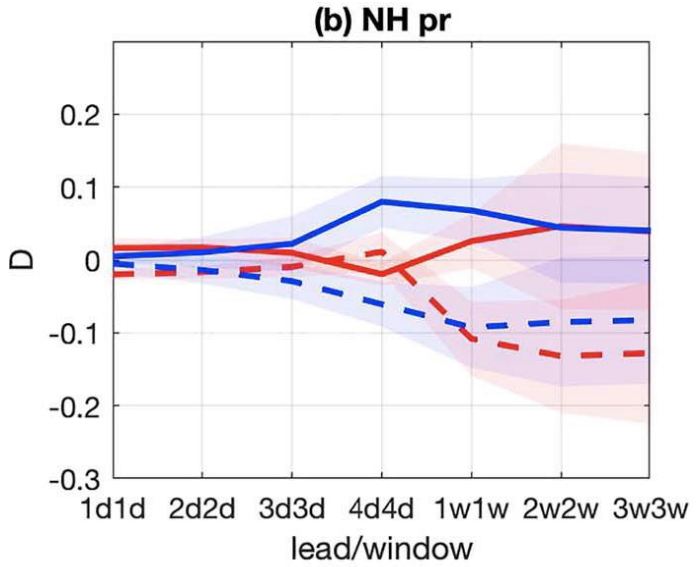
What about other MJO interactions (e.g. QBO, ARs)?



from Arcodia et al. 2020, JCLIM







from Dias and Kiladis 2019, GRL

Tropical Heating

Better tropical precip skill at short lead-times leads to better subseasonal precip skill in NH.

Skill is still relatively low

How well could we predict tropical precipitation?

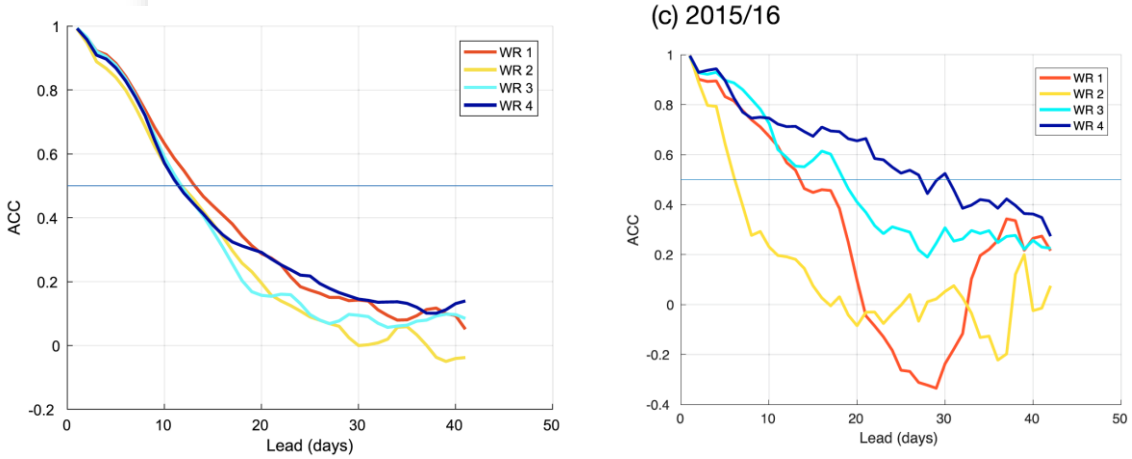
How much CONUS skill could we get from the tropics?

Weather Regimes

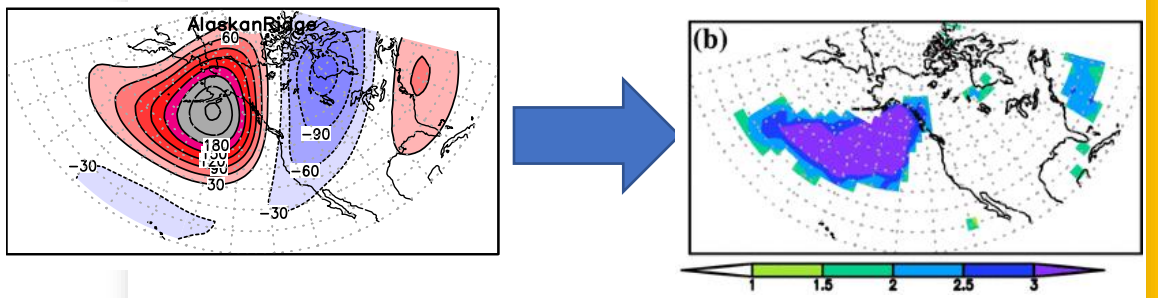
Pacific North America weather regimes predicted to ~15 days and longer in certain cases.

There is a relationship between these regimes and CONUS precipitation.

Can we represent that relationship and realize this predictability?

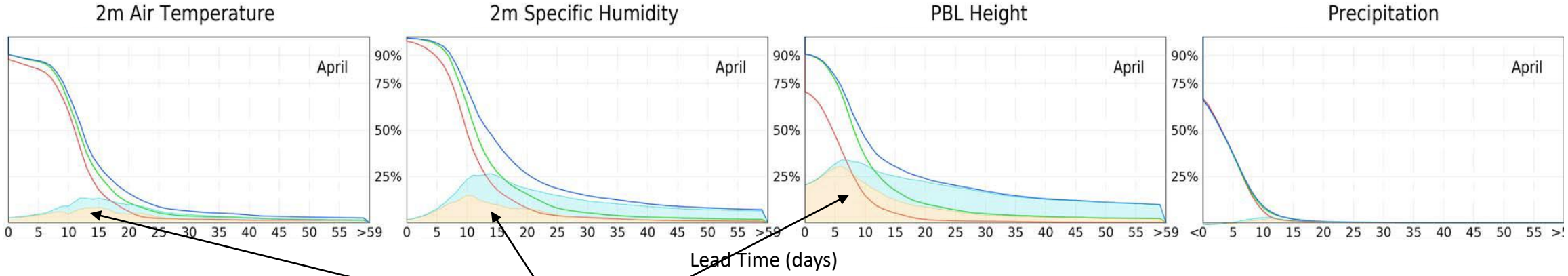


from Robertson et al. 2020, MWR



from Amini and Straus 2019, Clim Dyn

Fraction of Land Area Showing Significant Skill



Realized skill from Land ICs

- Atm/Ocn/Land ICs
- Atm & Ocn ICs
- Idealized land state

from Dirmeyer et al. 2018, JGR-Atm

Land-surface impacts prediction of T,q, and PBL, but does not translate to precipitation

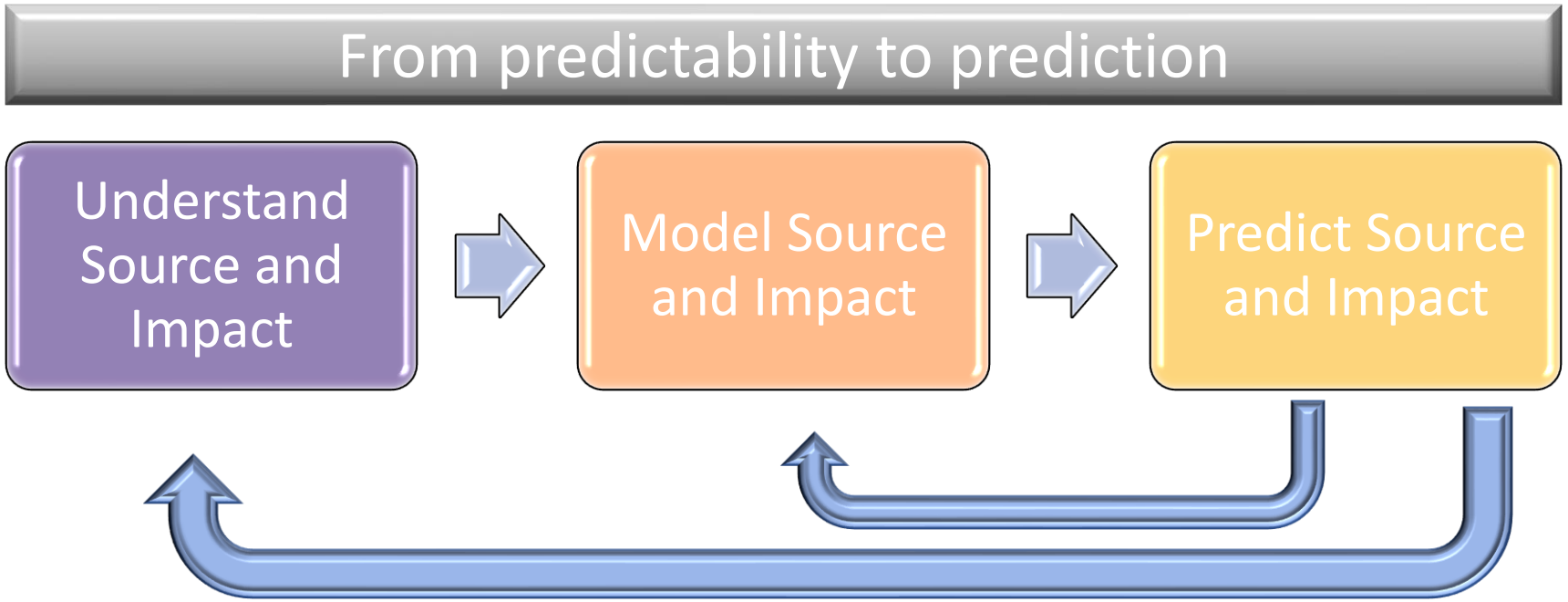
Model errors in convection

Land Surface

Can we fix this in our prediction models?

If we fix it, how much skill improvement can we get?

How can we make better predictions?



Summary

How good are our predictions now?

- Currently skill is low on average
- We can't measure all potentially useful forecasts
- Traditional skill metrics may be misleading

What is the limit of predictability?

- We don't know for sure
- There are forecasts of opportunity

How can we make better predictions?

- Focus on forecasts of opportunity
- Better understand and model **impacts** of the sources of predictability
- Acknowledge and quantify uncertainty